

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Serial No. : **10/565640**
Applicant : Lorger et al.
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Title : Downhole Hammer Drill
TC/A.U. : 3676
Examiner : **Bomar**
Docket No. : **5791**
Customer No. : 26936

Commissioner for Patents
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AMENDMENT AFTER FINAL REJECTION

Sir:

Please amend this application as follows:

Amendments to the Claims:

1. (withdrawn) A downhole hammer drill including:

a drive sub or chuck mounted on an air hammer casing; and
a reverse circulation drill bit having a bit shank mounted in splined relation to
said drive sub or chuck and a bit head adapted to extend below said chuck, an air
hammer motor exhausting down the splines, an annular groove in said bit shank
adjacent said bit head and extending to intersect the lower end of the bit shank splines,
a sleeve secured to said bit shank over the lower end of said bit shank splines and
substantially closing over said groove to form a manifold for exhaust air exiting said
splines, an upper air passage directing sample accelerating air from said manifold up a
sample recovery bore of said bit, said bit head having at least one lower air passage
therethrough and intersecting said manifold, said lower air passage having a lower end
directing air to a cutting face of the bit through an outlet through the side of the bit
head adjacent a gauge row thereof communicating with a channel passing from said
outlet to said cutting face.

2. (withdrawn) A downhole hammer drill according to claim 1, wherein said splines
are milled in the bit shank, the milling tool advancing the spline toward the bit head
and stopping short of the bit head to avoid the milling tool from removing bit head
material.

3. (withdrawn) A downhole hammer drill according to claim 1, wherein said groove
is formed by milling or turning, said groove forming a progressive change of section
between the splined portion of the bit shank and the bit head to avoid stress
concentration.

4. (withdrawn) A downhole hammer drill according to claim 1, wherein said sleeve has a section that substantially parallels the bottom surface of the groove to provide that said manifold is of substantially rectangular cross section.

5. (withdrawn) A downhole hammer drill according to claim 1, wherein said sleeve is adapted to cyclically open a port in a sidewall of said chuck to allow exhaust air to escape up the outside of the drill string to clear fines from the borehole.

6. (withdrawn) A downhole hammer drill according to claim 1, wherein said at least one lower air passage defined between the sample recovery bore and the side of the bit head adjacent the gauge row comprises one air passage for each carbide in the gauge row, the material of the bit head being relieved between the portions supporting the gauge row buttons to form the grooves, allowing the flushing air to pass to the face of the bit, entraining sample for recovery.

7. (withdrawn) A downhole hammer drill according to claim 1, wherein said lower air passage is formed by straight drilling at an angle to the drill bit axis from the side of the bit head adjacent the gauge row and extending to the sample recovery bore above the bit head, whereby a single drilling provides both the lower air passage and the upper air passage.

8. (currently amended) A downhole hammer drill including:

- a drive sub or chuck mounted on an air hammer drill casing; and
- a reverse circulation drill bit having a bit shank mounted in splined relation to said drive sub or chuck and a bit head adapted to extend below said drive sub or chuck, an air hammer motor in the air hammer drill casing exhausting down the splines, a plurality of upper air passages each opening from a spline in the region of the bit head and each inclined toward the axis of the bit and extending along the bit shank away from said bit head to intersect a sample recovery bore of said bit, said

upper air passages directing being configured to direct substantially all of the sample accelerating air from the said openings from a spline up the sample recovery bore
~~the sample recovery bore of said bit.~~

9. (Original) A downhole hammer drill according to claim 8, wherein spline-borne exhaust air is also directed through the bit head by at least one lower air passage therethrough.

10. (Original) A downhole hammer drill according to claim 9, wherein said at least one lower air passage has a lower end directing air to the cutting face of the bit through an outlet through the side of the bit head adjacent a gauge row thereof and communicating with a channel passing from the outlet to the cutting face.

11. (currently amended) A downhole hammer drill according to claim 10, wherein said at least one lower air passage is ~~formed as~~ a continuation of the drilling of each of the upper air passages.

12. (Original) A downhole hammer drill according to claim 11, wherein each said upper air passage and lower air passage are co-formed by a drilling from the gauge row at the location of the button, through the bit head and into the shank, to intersect the sample recovery bore.

13. (Original) A downhole hammer drill according to claim 8, wherein each said upper air passage is formed by a drilling from the position of a gauge row at the location of a carbide button, through the bit head and into the shank, to intersect the sample recovery bore, and wherein said drilling is counter bored at its lower end to form the carbide button mounting socket.

14. (previously presented) A downhole hammer drill according to claim 8, further comprising a dynamic air seal to a borehole formed by the downhole hammer drill in use.

15. (currently amended) A downhole hammer drill including:

a drive sub or chuck mounted on an air hammer drill casing; and
a reverse circulation drill bit having a bit shank mounted in splined relation to said drive sub or chuck and a bit head adapted to extend below said chuck, an air hammer motor exhausting down the splines, an exhaust air passage formed in said bit shank adjacent said bit head and adapted to receive air exhausted at the lower end of the bit shank splines, an upper air passage opening from said exhaust air passage in the region of the bit head and inclined toward the axis of the bit and extending along the bit shank away from said bit head to intersect a sample recovery bore of said bit, said upper air passage being configured to direct substantially all of the sample accelerating air from the said exhaust air passage up the sample recovery bore ~~an upper air passage intersecting said exhaust air passage and directing sample accelerating air from said exhaust air passage up a sample recovery bore of said bit, said bit head having at least one lower air passage therethrough and intersecting said exhaust air passage, said lower air passage having a lower end directing air to the cutting face of the bit through an outlet through the side of the bit head adjacent a gauge row thereof communicating with a channel passing from said outlet to said cutting face.~~

16. (previously presented) A downhole hammer drill according to claim 15, further comprising a dynamic air seal to a borehole formed by the downhole hammer drill in use.

17. (previously presented) A downhole hammer according to claim 8, wherein said upper air passages each open from a spline in the region of the bit head via an exhaust air passage formed in said bit shank adjacent said bit head.

18. (previously presented) A downhole hammer drill according to claim 17, wherein spline-borne exhaust air is also directed from the exhaust air passage through the bit head by at least one lower air passage.

Remarks/Arguments:

This is a reply to the office action of May 16.

We incorrectly included document WO03/004292 with the information disclosure statement. The correct document WO03/042492 is submitted herewith. The claims were found to meet the requirements for patentability over this and other references in the International Preliminary Examination Report.

The matters raised at item 2 of the office action have been addressed in the above amendment to claim 8. Claims 8 and 15 have also been amended to better distinguish the invention from the prior art of record.

In rejecting claims 8 and 9, the examiner cited some language from claim 15. We ask the examiner to consider whether that may have had an effect on his evaluation of claims 8 and 9 and if so, to give fresh consideration to them.

In any event, the rejection of claim 8 as anticipated by Kane is respectfully traversed. The air passages 80 of Kane et al. are not “upper” air passages in any appropriate context. In the present case, the air passages are “upper” relative to the source of air which is the “opening from a spline in the region of the bit head”. The Kane et al. disclosure, on the other hand, does not have any spline in the region of the bit head; the spline is instead confined to the upper half of the bit shank and the air is conveyed from the region of the splines by four small longitudinal drillings forming passages 74.

The clear purpose of the upper air passages of the present invention is to convey sample accelerating air from the lower end of the splines, through the material of the bit shank to intersect the sample recovery bore at a point significantly higher than the lower end of the splines. It does this by the upper air passages being “inclined toward

the axis of the bit away from said bit head” as recited in claim 8. The purpose is to get the air direction as parallel to the axis of the bit as possible so the air is directed into the sample recovery bore in an upward direction. The advantages of this are:

- (i) that the zone of depression between the cutting face and the point of intersection of the upper air passages and the sample recovery bore is maximized. This forms a low pressure buffer of volume sufficient to enhance the effect of sample recovery air passing from the lower air passages across the cutting face; and
- (ii) that the direction of the air flow is optimized into the direction in which the sample is to be conveyed, that is, up the drill string.

The examiner asserts that Kane et al. discloses that the passages 80 are “each inclined toward the axis of the bit away from said bit head”. In fact, at all material instances such as col. 4, lines 14, 25, 43-44, and 67, and col. 5 line 3, the passages are referred to as “lateral passages 80”. At col. 4, lines 59 to 61 “radial slots 80’ ... form the lateral passages 80”.

Referring to Fig 1 of Kane et al., the section view and the marked-on arrow imply that there is upward direction to the air flow effected by the passage 80. At col. 4, lines 23 to 28, the description of Kane et al. provides that air passes “through the passages 80 and is discharged into the central passage 54 in an upward direction to create a suction which aids in drawing cuttings through the exhaust holes 56.”

As a matter of engineering and fluid dynamics, the lateral nature of the passages 80 means that the air is in fact directed horizontally across the sample recovery bore 54, not up it. Despite the notional appearance of the annular ridge 90 cooperating with the radial slots 80’ to direct a passage 80 upwards as in a tube, in practical fact because 80 is a bore and 90 is an annulus the flow is not constrained to produce the effect implied. It is fair to surmise that air will be randomly directed across the top of the ridge at all possible angles as well as sideways around the annulus of 90.

We respectfully submit that there is no upturn of the passage 80 whatsoever. The passage 80 terminates in the horizontal plane, perpendicular to the bit axis. It is then that the exhaust air leaves passage 80 and exits into open space. The Kane et al. disclosure may encourage the lay reader to imagine the annular space between the end of passage 80 and the beginning of the curved ridge to be a continual passage with an upwardly curving outlet. However, close examination of figure 1, and detail figure 3, clearly reveals that an unrestrained horizontal airstream exiting the end of passage 80 may strike the curve 90. Thinking now in 3D, since it is an annular ridge and therefore conical, it is also curved in the opposite plane and the free airstream now in an open annulus will fly around the conical surface and whatever air may be directed upward on the conical surface will, due the exiting velocity and direction, continue to fly around the ever decreasing diameter and increasing verticality of the conical surface. It is therefore practically impossible that a useful upturned accelerating airflow will be achieved. Given that there would be a plurality of such unrestrained horizontal airstreams (the Kane et al. embodiment has 4) acting upon the curved conical surface, the resultant turbulence would render the apparatus ineffective for the intended outcome.

Further still, much of the available airflow is also necessarily directed toward the bit face for the entrainment and flushing of cuttings to the sample recovery holes (generally 2) and subsequently into the axial bore of the bit, and onward up the inner tube of the drill string. The sample recovery holes are generally as large a diameter as practicable to facilitate larger rock fragments, and are necessarily drilled at a slight angle (generally 15-20 degrees) to the axis of the bit to intersect the axial bore of said bit. The bit face air, laden with cuttings, has already been redirected to travel upward, initially at the slight angle constrained by the sample recovery hole and as exiting that hole into the free space in the axial bit bore, must now pass through a turbulent airstream exited from passages 80. Clearly, having 2 unrestrained airstreams of

intersecting one another essentially at right angles is detrimental to the directional velocity of both.

Insofar as any possible upturned airflow is intended it can only be generated secondarily (i.e., in small part) by the curved ridge which is clearly separated from lateral passages 80 by an open annular space. We therefore submit that Kane et al., while asserting an upward airflow emanating from passages 80, does not generate such airflow by inclination of said passages (or any passages, annular ridge 90 cannot reasonably be construed as a passage or part thereof) toward the bit axis away from the bit head as taught by the present application.

With reference to independent claims 8 and 15, both claims include the feature of a plurality of upper air passages each opening from a spline in the region of the bit head and each inclined toward the axis of the bit away from the bit head, so as to positively direct sample accelerating air from said openings from a spline up the sample recovery bore of said bit. We submit that this feature distinguishes the present invention from the disclosure of Kane et al. Nonetheless, the claims have been amended above to more clearly distinguish the present invention from the disclosure of Kane et al.

Claims 9 to 14 and 16 to 18 depend, directly or indirectly, from claim 8 or claim 15. We respectfully traverse the obviousness objections based on the combination of Kane et al. and Terlet et al. because the presently claimed invention is distinguished from Kane et al. by a feature with respect to which Terlet et al. is silent, i.e., that the upper air passage be configured to direct substantially all of the sample accelerating air from the said exhaust air passage up the sample recovery bore . Thus Terlet et al. does not overcome Kane's deficiencies as a reference.

We earnestly believe the claims now presented are patentable over the prior art of record, and that this application is now in condition for allowance.

Respectfully submitted,

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